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(54) **POWER SUPPLY FOR A TWO-WIRE MODULE**

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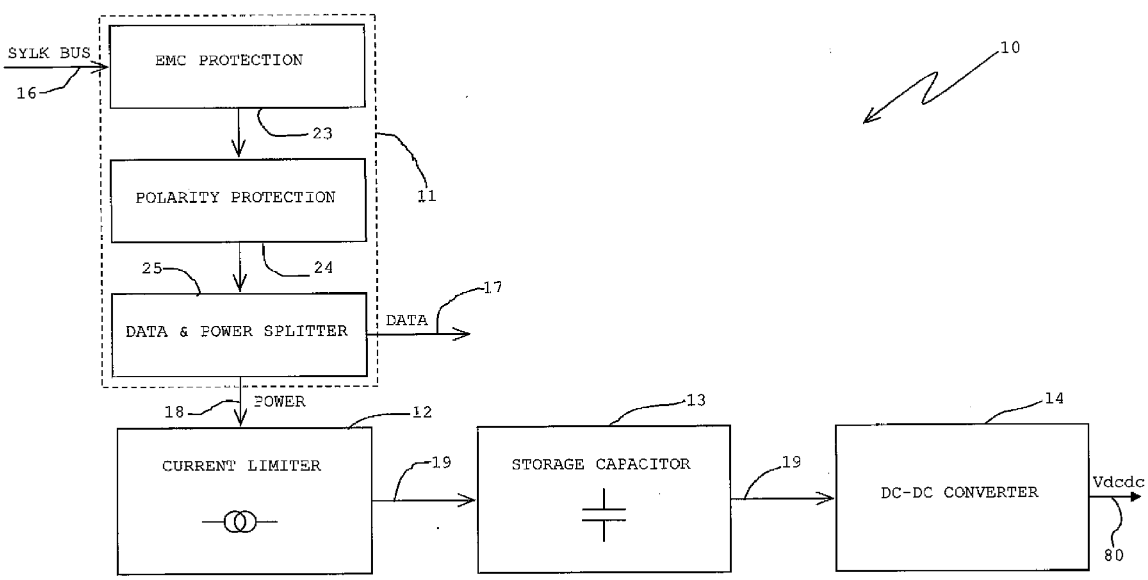
(57) **ABSTRACT**

A power supply approach and mechanism for electrical devices using a polarity-insensitive two-wire bus that can carry data and power. However, some devices, such as CO2 sensors and secure digital memory cards, may need certain amounts of energy for measuring and writing data, respectively, that are more intense than the amount of energy available on the two-wire bus. Sensor, card and other device data may be conveyed by the two-wire bus. The present approach and mechanism may convert power from the two-wire bus into intense energy that can enable the sensors, cards and other devices to satisfactorily operate. A current limiter may be incorporated to protect the two-wire bus from loss of data and energy for slave devices on the bus during a period of charging a storage cell in that an empty huge storage capacitor connected to bus directly could short the bus.



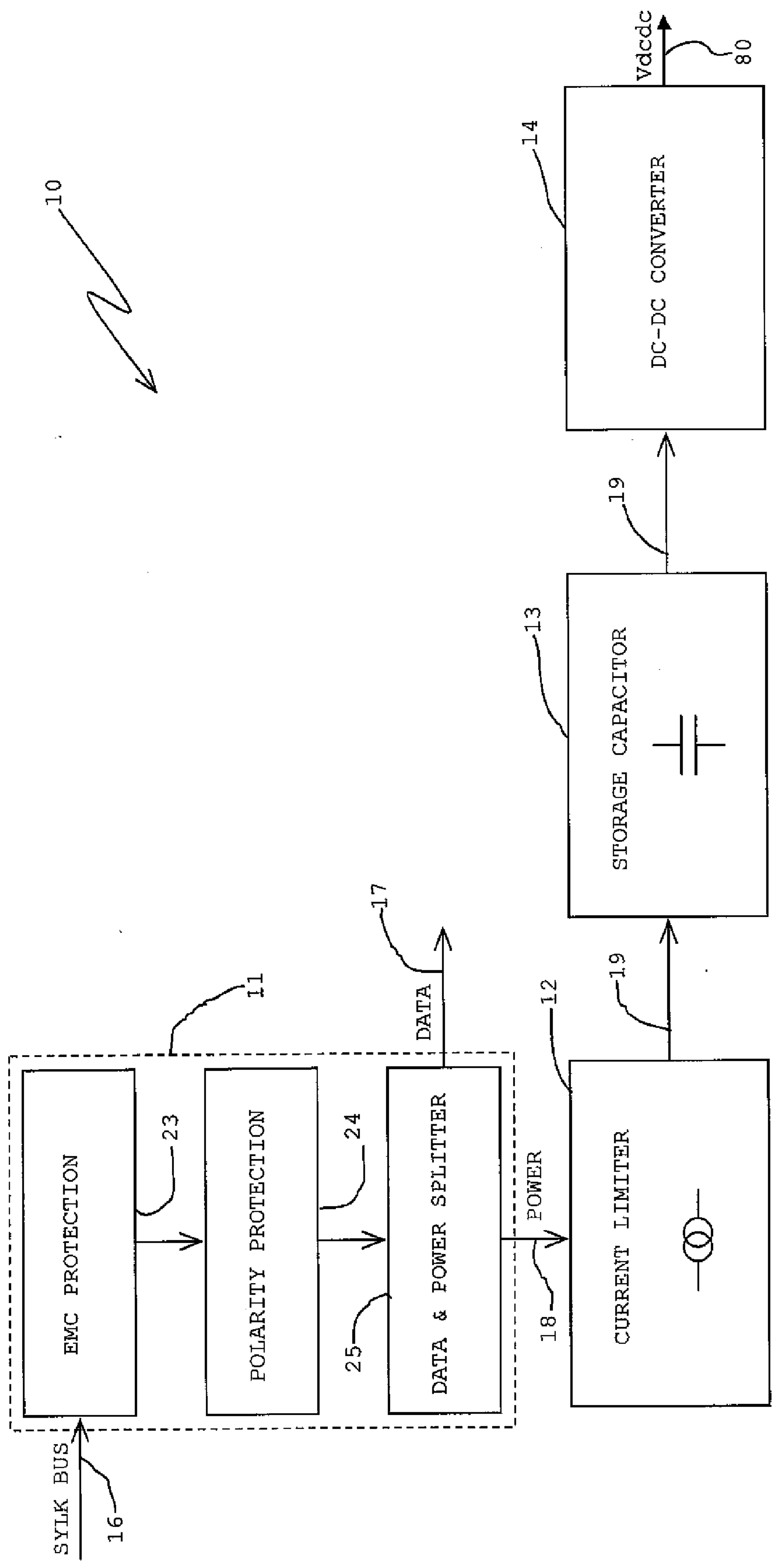

10
SYLK BUS
16
11
EMC PROTECTION
23
POLARITY PROTECTION
24
DATA & POWER SPLITTER
25
DATA
17
POWER
18
CURRENT LIMITER
12
19
STORAGE CAPACITOR
13
19
DC-DC CONVERTER
14
Vdcdc
80

FIGURE 1

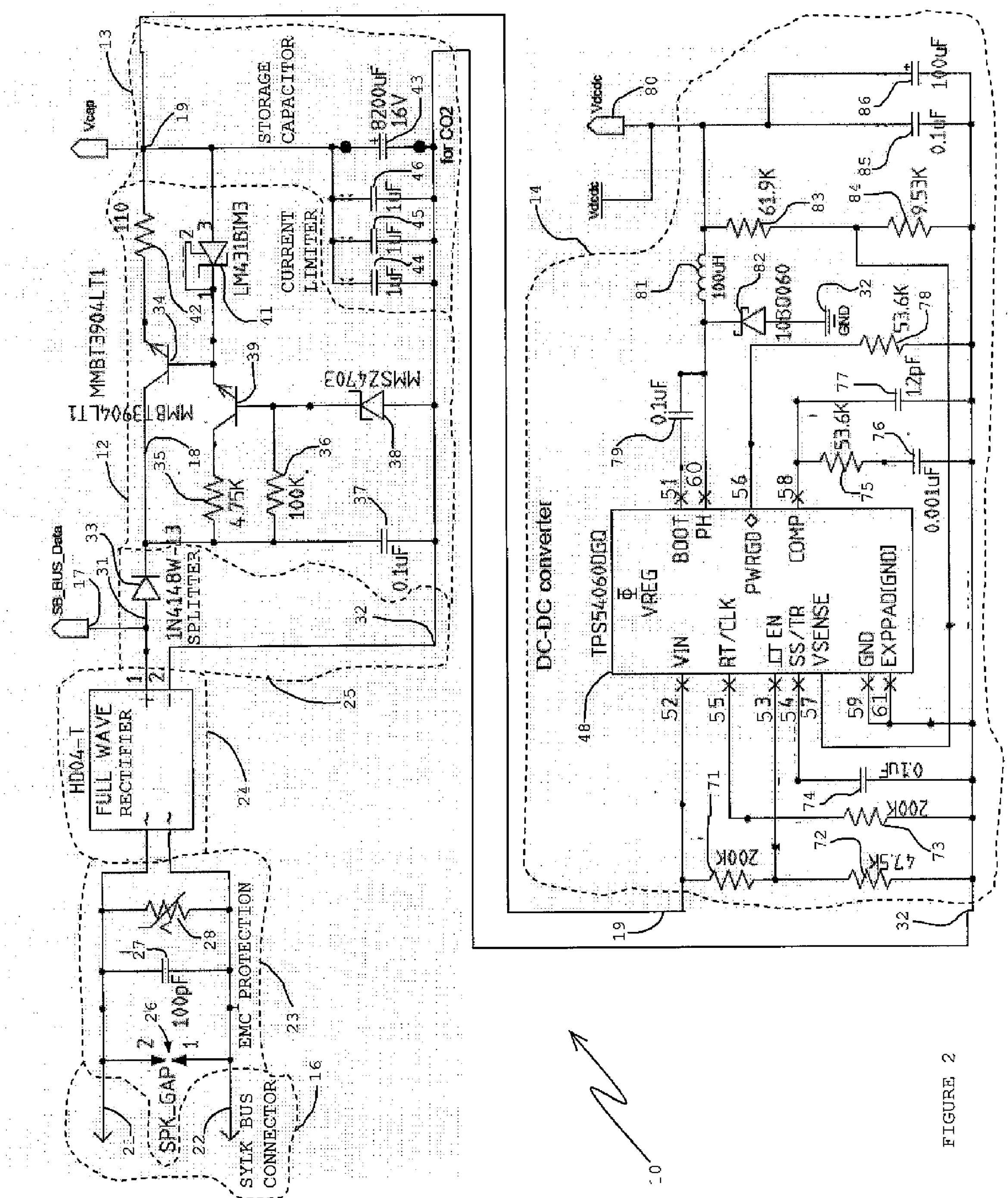

Vcap
SB_BUS_Data
STORAGE
CAPACITOR
8200uF
16V
for CO2
CURRENT
LIMITER
LM431BIM3
MMBT3904LT1
MMBT3904LT1
MMSZ4703
4.75K
100K
0.1uF
1N4148W-13
SPLITTER
HD04-T
FULL WAVE
RECTIFIER
EMC PROTECTION
100pF
SPK_GAP
SYLK BUS
CONNECTOR
DC-DC converter
TPS54060DGQ
VIN
RT/CLK
EN
SS/TR
VSENSE
GND
EXPPAD[GND]
VREG
BOOT
PH
PWRGD
COMP
Vdcdc
100uF
0.1uF
61.9K
9.53K
100uH
10BQ060
GND
53.6K
12pF
0.1uF
53.6K
0.001uF
0.1uF
200K
200K
47.5K

FIGURE 2

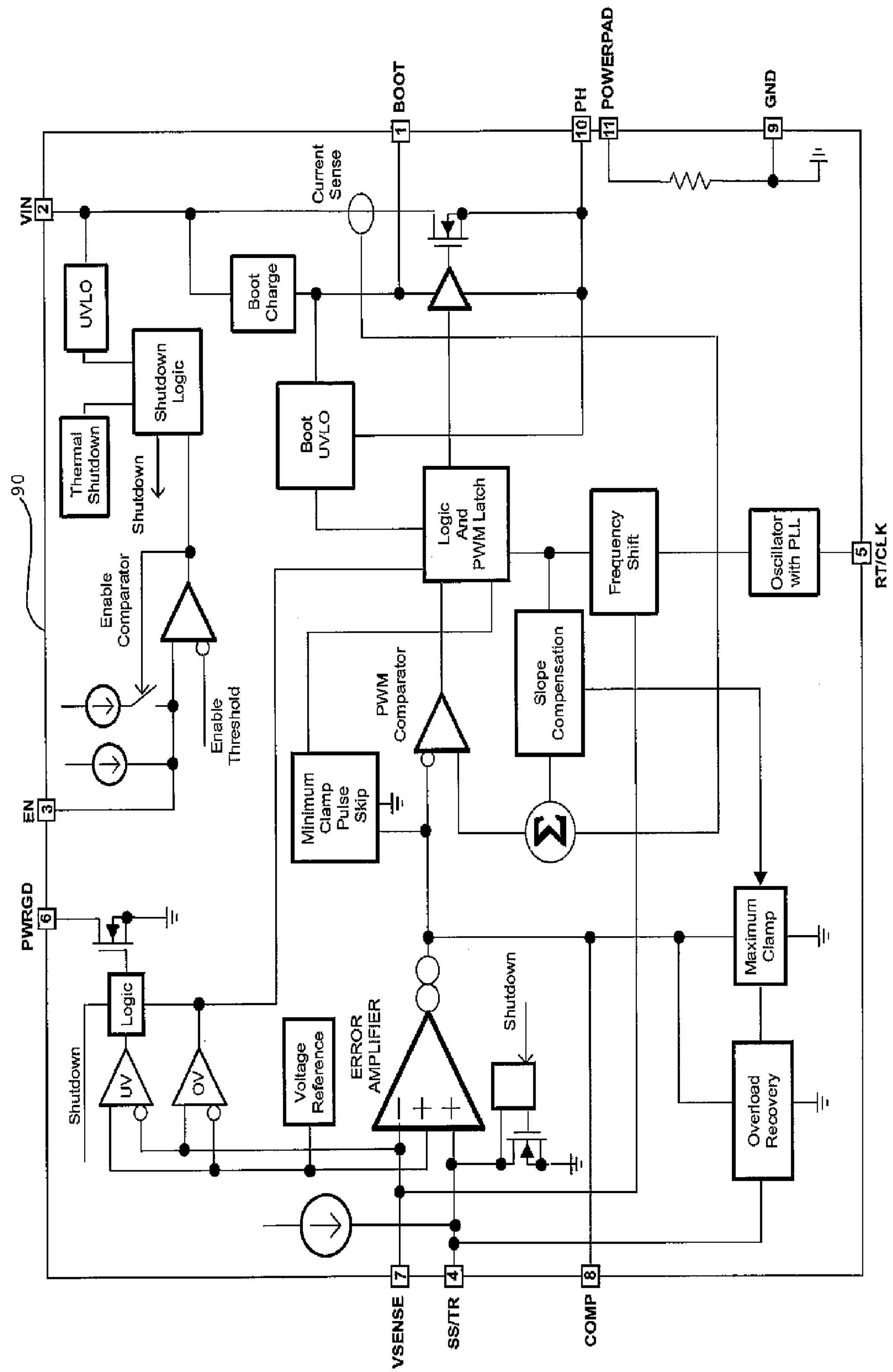

BOOT
PH
POWERPAD
GND
VIN
1
2
3
4
5
6
7
8
9
10
11
Current Sense
UVLO
Boot Charge
Shutdown Logic
Thermal Shutdown
Shutdown
Boot UVLO
90
Enable Comparator
Logic And PWM Latch
Frequency Shift
Oscillator with PLL
RT/CLK
Enable Threshold
PWM Comparator
Slope Compensation
Minimum Clamp Pulse Skip
EN
PWRGD
Logic
Shutdown
UV
OV
Voltage Reference
ERROR AMPLIFIER
Shutdown
Maximum Clamp
Overload Recovery
VSENSE
SS/TR
COMP

FIGURE 3

POWER SUPPLY FOR A TWO-WIRE MODULE

BACKGROUND

[0001] The present disclosure pertains to power supplies and particularly to power supplies designed for providing certain kinds of outputs.

SUMMARY

[0002] The disclosure reveals a power supply approach and mechanism for electrical devices using a polarity-insensitive two-wire bus that can carry data and power. However, some devices, such as CO2 sensors and secure data or digital memory cards, may need amounts of energy for measuring and/or writing data, respectively, that are more intense than the amount available on the two-wire bus. Data for the sensors may be conveyed by the two-wire bus. The present approach and mechanism may convert power from the two-wire bus into a form of energy that can enable the sensors and cards to satisfactorily to measure and/or write data. A current limiter may be incorporated to protect the two-wire-bus from loss of data and energy for slave devices on the bus during a period of charging of the storage cell in that an empty huge capacitor connected to bus directly could totally short the bus. The present approach and mechanism may be applicable to other electrical devices that utilize the two-wire bus for conveying data but need more intense energy than is available on the bus to operate adequately.

BRIEF DESCRIPTION OF THE DRAWING

[0003] FIG. **1** is a diagram of a module having a two-wire connection and a sub-module for providing extra power to the module when needed;

[0004] FIG. **2** is a diagram showing circuit details of the module in FIG. **1**; and

[0005] FIG. **3** is a functional block diagram of a DC to DC converter.

DESCRIPTION

[0006] The present approach and mechanism may incorporate one or more processors, computers, controllers, user interfaces, wireless and/or wire connections, and/or the like, in an implementation described and/or shown herein.

[0007] This description may provide one or more illustrative and specific examples or ways of implementing the present system and approach. There may be numerous other examples or ways of implementing the system and approach.

[0008] The present approach may solve an issue of many wires needed for having features like CO2, humidity, temperature measurement, LCD and buttons user interface and secure digital card writing available on a two-wire sylk sensor system.

[0009] Wiring for a multi-point transfer today may require up to eight wires running and terminating at one or more sensors. Sylk™ (sylk) bus technology may be available from Honeywell International Inc. and may allow virtually all of the point information to be sent on just two polarity insensitive wires thereby saving installation time, wiring errors and materials. But a drawback may be the limited amount of instantaneous energy available from the sylk bus to the sensor. To date, applications like CO2 measurement and secure digital (SD) card writing have not necessarily been possible to offer on the sylk bus, because of a lack of quick presence of energy when needed.

[0010] A two-wire bus approach may be described in U.S. Pat. No. 7,966,438, issued on Jun. 21, 2011, and entitled "Two-Wire Communications Bus System". U.S. Pat. No. 7,966,438, issued on Jun. 21, 2011, is hereby incorporated by reference.

[0011] Marketing may have labeled the two-wire approach as "game changing". The approach is possible by incorporating a new current limited power supply circuit to charge a local capacitor/storage cell. An onboard microcontroller may monitor the voltage in the storage cell and calculate when there is sufficient energy in the cell to conduct an energy intensive action like a CO2 measurement or writing of a flash memory.

[0012] FIG. **1** is a diagram of an example two-wire mechanism, module, approach or device **10** that may have a sub-module **11**. The module or device may be for a CO2 or some other sensor or electronic function requiring energy intensive action. Sub-module or circuit **11** may incorporate an electromagnetic compatibility (EMC) protection circuit **23**, a polarity protection (e.g., a rectifier) circuit **24** and a data and power splitter **25**. An output **18** from sub-module **11** may go to a current limiter **12**. An output **19** may go from current limiter **12** to a storage capacitor circuit **13**. An output **19** may go from capacitor **13** to a DC-DC converter **14**. Power sub-module **11** may have a connection with a sylk bus **16** to provide power and a data. Data may be taken from a splitter circuit **25**. A power connection may be made from power sub-module **11** to current limiter **12**.

[0013] FIG. **2** is a diagram that shows more details of mechanism, module, approach or device **10** of FIG. **1**. A sylk bus connector **16** may have two conductors **21** and **22** connected to an ECM protection circuit **23**. Conductors **21** and **22** of the sylk bus may convey power and data signals to sylk module **11**. EMC protection circuit **23** may have a spark gap **26** across conductors or lines **21** and **22**. A 100 pico farad capacitor **27** and a varistor **28** may be connected across lines **21** and **22** in circuit **23**.

[0014] Lines **21** and **22** may proceed through circuit **23**. Circuit **23** may have a full-wave rectifier for providing polarity protection. An output line **31** may be connected to an anode of a diode **33** of splitter circuit **25**. Data may be picked off at terminal **17** connected to the anode of diode **33**. Power from a cathode of diode **33** may proceed along a line **18** to an input of current limiter **12**. Line **32** from circuit **24** to splitter **25** may be regarded as a common reference terminal or ground for circuit **25**, current limiter **12**, storage capacitor **13**, and DC-DC converter **14**.

[0015] Line **18** may be connected to a collector of an NPN transistor **34**, a first end of a 4.75K ohm resistor **35**, a first end of a 100K ohm resistor **36**, and a first terminal of a 0.1 microfarad capacitor **37**. A second terminal of capacitor **37** may be connected to line **32**. A second end of resistor **36** may be connected to a cathode of a zener diode **38** and a base of an NPN transistor **39**. An anode of zener diode **38** may be connected to line **32**. Zener diode **38** is not necessarily needed for a current limiter but may provide additional voltage protection to prevent a voltage higher than the 16 volts on storage capacitor **43** having, for instance, a rating of 8200 micro farads at 16 volts.

[0016] A second end of resistor **35** may be connected to a collector of transistor **39**. An emitter of transistor **39** may be connected to a base of transistor **34** and to a cathode of a three terminal zener diode **41** having a low voltage rating and sharp characteristics. An emitter of transistor **34** may be connected to a first end of a 110 ohm resistor **42**. A second end of resistor **42** may be connected to an anode of zener diode **41** and to an output line **19** of current limiter **12**. A third terminal of zener diode **41** may be connected to the cathode of diode **41**.

[0017] Lines **19** and **32** from current limiter **12** may go to a storage capacitor circuit **13**. Line **19** may be connected to a positive terminal of an 8,200 microfarad polarity sensitive capacitor **43**. A negative terminal of capacitor **43** may be connected to line **32**. Three one micro farad capacitors **44**, **45** and **46** may be connected in parallel with capacitor **43**. Output lines **19** of storage capacitor circuit **13** may be connected to a DC to DC converter **14** voltage regulator integrated circuit (IC) **48**. Circuit **48** may be a TPS54060 chip available from, for example, certain vendors of Texas Instruments products.

[0018] The discrete circuitry supporting IC **48** may be as shown in FIG. **2** or modified for a particular use. An example as shown for converter circuit **14** may have line **19** connected to a terminal **52** for a voltage in to IC **48**. Line **32** may be connected to ground terminals **59** and **61** of IC **48**.

[0019] A 200K ohm resistor **71** may have a first end connected to line **19** and a second end connected to an EN (enable) terminal **53** of IC **48**. A 47.5K ohm resistor **72** may have a first end connected to terminal **53** and a second end connected to line **32**. A 200K ohm resistor **73** may have a first end connected to a RT/CLK (timing resistor and external clock) terminal **55** and a second end connected to line **32**. A 0.1 micro farad capacitor **74** may have a first terminal connected to an SS/TR (slow start and tracking) terminal **54** of IC **48** and a second terminal connected to line **32**.

[0020] A 53.6K ohm resistor **75** may have a first end connected to a COMP (compensation) terminal **58** of IC **48**. A second end of resistor **75** may be connected to a first terminal of a 0.001 micro farad capacitor **76**. A second terminal of capacitor **76** may be connected to line **32**. A 12 pico farad capacitor **74** may have a first terminal connected to terminal **58** of IC **48** and a second terminal connected to line **32**. A 53.6 ohm resistor **78** may have a first end connected to a PWRGD (power good) terminal **56** of IC **48**, and a second end connected to line **32**.

[0021] A 0.1 micro farad capacitor **79** may have a first terminal connected to a BOOT (bootstrap voltage) terminal **51** and a second terminal connected to a PH terminal **60** of IC **48**. A first terminal of a 100 micro henry inductor **81** may have a first terminal connected to terminal **60** and a second terminal connected to a V_{DCDC} output terminal **80**. A zener diode **82** may have a cathode connected to terminal **60** and an anode connected to line **32**.

[0022] A 61.9K ohm resistor **83** may have a first end connected to terminal **80** and a second end connected to a VSENSE (voltage sense) terminal **57** of IC **48**. A first end of a 9.53K ohm resistor **84** may have a first end connected to terminal **57** and a second end connected to line **32**.

[0023] A 0.1 micro farad capacitor **85** may have a first terminal connected to terminal **80** and a second terminal connected to line **32**. A polarity sensitive 100 micro farad capacitor **86** may have a positive terminal connected to terminal **80** and a negative terminal connected to line **32**.

[0024] FIG. **3** is a Texas Instruments Inc. (TI) functional block diagram **90** of IC **48**. Pin numbers (i.e., in the small square tabs) in diagram **90** plus a number **50** may correspond to pin numbers for IC **48** in FIG. **2**, e.g., pin number **4** (SS/TR) of diagram **90** plus **50** equals pin number **54** (SS/TR) of IC **48**.

[0025] Some of the less common parts in diagram **80** may be noted. Varistor **28** may clamp a voltage in both directions, such as an AC voltage, whereas a zener diode may clamp a voltage in just one direction. Varistor **28** may have a part number V56MLA1206NH and be available a from a Littlefuse parts vendor. Full wave rectifier **24** may be a diode bridge HD04-T available from Diodes Inc. or a Schottky diode bridge MB16S from Micro Commercial Components. Diode **33** may have a part number 1N4148W-13 and be available from a Diodes Incorporated parts vendor. Component **33** may have a reverse recovery time of four nanoseconds. Transistors **34** and **39** may have a part number MMBT3904LT1 and be available from a Motorola parts vendor. Zener diode **38** may have a part number MMSZ4703 and be available from a General Semiconductor parts vendor. Diode **41** may have a part number LM431BIM3 and be available from a National Semiconductor parts vendor. Diode **41** may be an adjustable precision zener shunt regulator. Diode **82** may have a part number 10BQ060 and be available from a Sensitron Semiconductor parts vendor. Component **82** may be a Schottky rectifier.

[0026] To recap, a power supply for a two-wire bus connected electrical module, may incorporate a protection circuit having an input for connection to a two-wire bus, a data and power splitter connected to the protection circuit, a current limiter connected to the data and power splitter, a energy storage cell connected to the current limiter, and a DC to DC converter connected to the energy storage cell. An output of the DC to DC converter may provide more intense energy per unit of time than the two-wire bus.

[0027] The protection circuit may incorporate an electromagnetic compatibility protection sub-circuit and a polarity protection sub-circuit.

[0028] The energy storage cell may incorporate a capacitor having a value greater than one microfarad.

[0029] The electromagnetic compatibility protection sub-circuit may incorporate a spark gap and a varistor.

[0030] The polarity protection sub-circuit may incorporate a rectifier.

[0031] The data and power splitter may incorporate a diode having an anode connected to an output of the polarity protection sub-circuit and a cathode connected to an input of the current limiter.

[0032] The current limiter may incorporate one or more transistors, and one or more zener diodes to limit a rate of flow of current to the energy storage cell.

[0033] The DC to DC converter may be selected from a group consisting of step-down regulators and buck converters.

[0034] An electrical input from the two-wire bus to the protection circuit may incorporate a first magnitude of energy for a first duration of time. An electrical output from the DC to DC converter may incorporate a second magnitude of energy for a second duration of time. The second magnitude of energy may be greater than the first magnitude of energy. The first duration of time may be greater than the second duration of time.

[0035] A mechanism for providing energy to a device, may incorporate a two-wire bus capable of providing power and data, an electromagnetic compatibility and polarity protection circuit connected to the two-wire bus, a splitter for extracting data from the two-wire bus, a storage capacitor, a current limiter for limiting an amount of current from the splitter to the storage capacitor, and a DC-DC converter for providing an electrical energy supply having greater intensity than the electrical energy supply available on the two-wire input.

[0036] The data on the two-wire bus may be from a CO2 module. The electrical energy supply from the DC-DC converter may be for sufficiently powering the CO2 module in a measurement mode. The energy supply on the two-wire bus may often be insufficient for the CO2 module in a measurement mode.

[0037] The data on the two-wire input may be for a secure digital card. The energy supply from the DC-DC converter may be for sufficiently powering the secure digital card in a writing mode. The energy supply on the two-wire bus may often be insufficient for the secure digital card in a writing mode.

[0038] The mechanism may further incorporate a controller connected to the storage capacitor. The controller may monitor a voltage at the storage capacitor and calculate when there is enough energy in the storage capacitor to provide an amount of intensive energy for operating a certain electrical device, or the controller may ensure an initial time period for storing energy in the storage capacitor to provide enough intensive energy for operating a certain electrical device without the controller monitoring the voltage at the storage capacitor. Energy from the two-wire bus may incorporate an insufficient amount of intensive energy for operating a certain electrical devices.

[0039] An approach for providing data and power relative to an electrical device, may incorporate providing a two-wire bus for conveying power and data, connecting a splitter to the two-wire bus for obtaining data from the two-wire bus, limiting current from the two-wire bus going to a storage cell, and monitoring an amount of energy in the storage cell to determine when there is a sufficient amount of energy to enable an energy intensive action by an electrical device.

[0040] The amount of energy in the storage cell may be monitored by a controller measuring a voltage at the storage cell and calculating when there is a sufficient amount of energy in the storage cell to enable an energy intensive action by the electrical device.

[0041] The approach may further incorporate providing electromagnetic compatibility protection between the two-wire bus and the splitter.

[0042] The approach may further incorporate protecting the splitter or the storage cell from incorrect electrical polarities on the two-wire bus.

[0043] The approach may further incorporate performing a DC to DC conversion of electrical energy from the storage cell to a greater amount of energy per a smaller duration of time that available from the storage cell.

[0044] The electrical device may be selected from a group consisting of sensors and memories.

[0045] The two-wire bus is a polarity insensitive bus.

[0046] In the present specification, some of the matter may be of a hypothetical or prophetic nature although stated in another manner or tense.

[0047] Although the present system and/or approach has been described with respect to at least one illustrative example, many variations and modifications will become apparent to those skilled in the art upon reading the specification. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the related art to include all such variations and modifications.

What is claimed is:

1. A power supply for a two-wire bus connected electrical module, comprising:

a protection circuit having an input for connection to a two-wire bus;

a data and power splitter connected to the protection circuit;

a current limiter connected to the data and power splitter;

a energy storage cell connected to the current limiter; and

a DC to DC converter connected to the energy storage cell; and

wherein an output of the DC to DC converter can provide more intense energy per unit of time than the two-wire bus.

2. The supply of claim **1**, wherein the protection circuit comprises:

an electromagnetic compatibility protection sub-circuit; and

a polarity protection sub-circuit.

3. The supply of claim **1**, wherein the energy storage cell comprises a capacitor having a value greater than one microfarad.

4. The supply of claim **2**, wherein the electromagnetic compatibility protection sub-circuit comprises a spark gap and a varistor.

5. The supply of claim **2**, wherein the polarity protection sub-circuit comprises a rectifier.

6. The supply of claim **2**, wherein the data and power splitter comprises a diode having an anode connected to an output of the polarity protection sub-circuit and a cathode connected to an input of the current limiter.

7. The supply of claim **1**, wherein the current limiter comprises one or more transistors, and one or more zener diodes to limit a rate of flow of current to the energy storage cell.

8. The supply of claim **1**, wherein the DC to DC converter is selected from a group consisting of step-down regulators and buck converters.

9. The supply of claim **1**, wherein:

an electrical input from the two-wire bus to the protection circuit comprises a first magnitude of energy for a first duration of time;

an electrical output from the DC to DC converter comprises a second magnitude of energy for a second duration of time;

the second magnitude of energy is greater than the first magnitude of energy; and

the first duration of time is greater than the second duration of time.

10. A mechanism for providing energy to a device, comprising:

a two-wire bus capable of providing power and data;

an electromagnetic compatibility and polarity protection circuit connected to the two-wire bus;

a splitter for extracting data from the two-wire bus;

a storage capacitor;

a current limiter for limiting an amount of current from the splitter to the storage capacitor; and

a DC-DC converter for providing an electrical energy supply having greater intensity than the electrical energy supply available on the two-wire input.

11. The mechanism of claim **10**, wherein:
the data on the two-wire bus is from a CO2 module;
the electrical energy supply from the DC-DC converter is for sufficiently powering the CO2 module in a measurement mode; and
the energy supply on the two-wire bus is often insufficient for the CO2 module in a measurement mode.

12. The mechanism of claim **10**, wherein:
the data on the two-wire input is for a secure digital card; and
the energy supply from the DC-DC converter is for sufficiently powering the secure digital card in a writing mode.

13. The mechanism of claim **10**, further comprising:
a controller connected to the storage capacitor; and wherein:
the controller monitors a voltage at the storage capacitor and calculates when there is enough energy in the storage capacitor to provide an amount of intensive energy for operating a certain electrical device, or the controller ensures an initial time period for storing energy in the storage capacitor to provide enough intensive energy for operating a certain electrical device without the controller monitoring the voltage at the storage capacitor; and
energy from the two-wire bus comprises an insufficient amount of intensive energy for operating a certain electrical devices.

14. A method for providing data and power relative to an electrical device, comprising:
providing a two-wire bus for conveying power and data;
connecting a splitter to the two-wire bus for obtaining data from the two-wire bus;
limiting current from the two-wire bus going to a storage cell; and
monitoring an amount of energy in the storage cell to determine when there is a sufficient amount of energy to enable an energy intensive action by an electrical device.

15. The method of claim **14**, wherein the amount of energy in the storage cell is monitored by a controller measuring a voltage at the storage cell and calculating when there is a sufficient amount of energy in the storage cell to enable an energy intensive action by the electrical device.

16. The method of claim **14**, further comprising providing electromagnetic compatibility protection between the two-wire bus and the splitter.

17. The method of claim **14**, further comprising protecting the splitter or the storage cell from incorrect electrical polarities on the two-wire bus.

18. The method of claim **14**, further comprising performing a DC to DC conversion of electrical energy from the storage cell to a greater amount of energy per a smaller duration of time that available from the storage cell.

19. The method of claim **14**, wherein the electrical device may be selected from a group consisting of sensors and memories.

20. The method of claim **14**, wherein the two-wire bus is a polarity insensitive bus.

* * * * *